HIGH PRODUCTION VOLUME (HPV)

CHALLENGE PROGRAM

FINAL SUBMISSION

For

1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio)

Prepared by
The American Chemistry Council
Petroleum Additives Panel
Health, Environmental and Regulatory Task Group

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LIST OF MEMBER COMPANIES IN THE
HEALTH, ENVIRONMENTAL AND REGULATORY TASK GROUP

The Health, Environmental, and Regulatory Task Group (HERTG) of the American Chemistry Council Petroleum Additives Panel includes the following member companies:

Afton Chemical Corporation (formerly Ethyl Corporation)

Chevron Oronite Company, LLC

Infineum

The Lubrizol Corporation

1.0 INTRODUCTION

In March 1999, the American Chemistry Council Petroleum Additives Panel Health, Environmental and Regulatory Task Group (HERTG), and its participating member companies committed to address data needs for certain chemicals listed under the Environmental Protection Agency (EPA) High Production Volume (HPV) Chemical Challenge Program. A test plan to address testing information for 1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio), CAS Number: 89347-09-1, was submitted to the EPA in 2003 to follow up on that commitment.

In preparing the test plan the following steps were undertaken:

Step 1: A review of the literature and confidential company data was conducted on the physicochemical properties, mammalian toxicity endpoints, and environmental fate and effects for 1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio), using its CAS number, CAS name, and synonyms. Searches included the following sources: MEDLINE, BIOSIS, CANCERLIT, CAPLUS, CHEMLIST, EMBASE, HSDB, RTECS, EMIC, and TOXLINE databases; the TSCATS database for relevant unpublished studies on these chemicals; and standard handbooks and databases (e.g., Sax, CRC Handbook on Chemicals, IUCLID, Merck Index, and other references) for physicochemical properties.

Step 2: The compiled data was evaluated for adequacy in accordance with the EPA guidance documentation.

Step 3: Data Gaps were identified and a commitment was made to fill the gaps.

This final submission summarizes the results of the test plan.

2.0 GENERAL SUBSTANCE INFORMATION

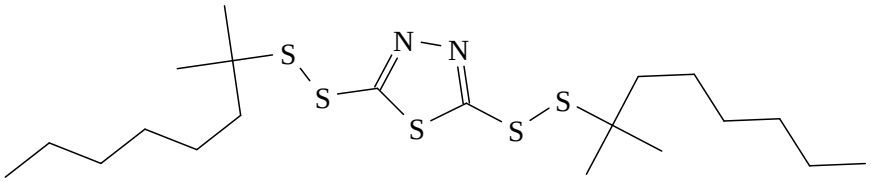
Chemical Name: 1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio)

Chemical Abstract Service Registry Number: CAS No.: 89347-09-1

Molecular Formula: $C_{20}H_{38}N_2S_5$

Molecular Weight: 466.84 g/mol

Structural Diagram:



1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio)

3.0 USE AND MANUFACTURE INFORMATION

3.1 Use Information

1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) is used to formulate finished greases and lubricating oils including industrial, gear, automatic transmission and some types of automotive crankcase, heavy duty diesel and medium speed diesel oils. In these applications, it is used as an ashless copper corrosion inhibitor and extreme pressure (EP) agent.

In lubricant applications, 1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) is generally used in dosages starting at 0.01 wt.% for industrial oils and ranging from 0.045 wt.% to 0.15% in automotive oils depending on the type of basestock. To obtain extreme pressure properties, treat levels are generally in the range of 0.15 to 0.30 wt. %.

1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) is also used as a sulfur deactivator, corrosion inhibitor and antioxidant in gasoline, heating oil and Liquified Petroleum Gas. However, its use in these applications is very limited. Fuel treatment levels are in the range of 10 - 100 PPM depending upon the active sulfur level of the fuel.

1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) is generally sold to fuel blenders in its neat form, while finished oil blenders receive this component in both its neat form and in additive packages, where the concentration typically ranges from 0.3 to 3.5 wt.%. These additive packages are then blended into finished oils where the typical concentration of 1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) ranges from 0.01 to 0.30 wt.% in the finished oil.

3.2 Manufacture

1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) is manufactured and blended into additive packages at plants owned by members of the HERTG. As manufactured, this additive

component contains 80 - 90 wt.% 1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) and 10 - 20 wt.% residual 2-Mercapto-5-tert-nonyldithio-1,3,4-thiadiazole. The 10 – 20 wt.% 2-Mercapto-5-tert-nonyldithio-1,3,4-thiadiazole in the additive component is residual from the manufacturing process and is not isolated during the life cycle of the additive component. Finished lubricants are blended at facilities owned by HERTG customers. The neat component is shipped in 55-gallon steel drums while additive packages containing this component are shipped to customers in bulk in ships, isocontainers, railroad tank cars, tank trucks or in 55-gallon steel drums. The bulk additive packages are stored in bulk storage tanks at the customer blending sites. Finished oils are blended by pumping the lubricating oil blend stocks and the additive package from their storage tanks through computer controlled valves that meter the precise delivery of the components into a blending tank. After blending, the finished lubricant products are sold in bulk and shipped in tank trucks to large industrial users, such as manufacturing facilities and facilities that service truck fleets and passenger motor vehicles. Finished lubricants are also packaged into 55-gallon drums, 5-gallon pails, and one-gallon and one-quart containers for sale to smaller industrial users. Sales of lubricants in one-gallon and one-quart containers to consumers at service stations or retail specialty stores also occur.

4.0 PHYSICAL CHEMICAL PROPERTIES

4.1 Vapor Pressure

The vapor pressure was characterized using MPBPWIN (v 1.41). The estimated vapor pressure was 8.83×10^{-12} mm Hg at 25°C.

4.2 Boiling Point

Determination of the boiling point of this thiadiazole is not possible because the substance will decompose (at the sulfur bridging bonds) during heating resulting in a wide boiling point range not applicable to the actual substance itself. It is expected that this substance will begin to decompose at > 200ºC.

4.3 Octanol-Water Partition Coefficient and Water Solubility

An octanol-water partition coefficient of 1.72-2.94 at 21^{o} C was previously reported in the HERTG's August 13, 2003 Test Plan. This was for the manufactured mixture of 80 - 90 wt.% 1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) and 10 - 20 wt.% residual 2-Mercapto-5-tert-nonyldithio-1,3,4-thiadiazole.

The HERTG has since identified a Japanese study that reports an experimentally derived octanol-water partition coefficient for 1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) of 3.96-4.55.[1] This experimentally derived octanol – water partition coefficient was used to estimate the water solubility for 1,3,4-Thiadiazole, 2,5-bis(tert-nonyldithio) using WSKOW (v 1.41). The estimated water solubility at 25°C is 0.1517-0.4839 mg/L.

[1] CITI, 1991. Japan (Report in Japanese).

5.0 ENVIRONMENTAL FATE DATA

5.1 Biodegradability

The Modified MITI Test (OECD 301C) was used to evaluate the biodegradability of 1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio). After the 28-day test, the extent of biodegradation was 2%-5% based on oxygen uptake and HPLC determination, respectively.

5.2 Hydrolysis

This compound does not contain a functional group that could undergo hydrolytic reaction; the alkane, sulfide and thiadiazole ring that characterize this substance all have a low potential for hydrolysis. In addition, the solubility of this substance in water is low. Given the expected stability of this substance and that only a small amount of stable material will partition into water, hydrolysis testing was not conducted.

5.3 Photodegradation

The Atmospheric Oxidation Potential (AOP) of this substance was characterized using the modeling program AOPWIN (v 1.91). The calculated half-life was 16.55 minutes.

5.4 Fugacity Modeling

The relative distribution of 1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio) among environmental compartments was determined using Level I Fugacity modeling (the EQC model – a.k.a. Mackay Equilibrium Criterion Model). The model assumes that the chemical is distributed in a closed environment at equilibrium and that no degradation, advection, or inter-media transport processes are taking place (no sedimentation or wet deposition).

Water solubility, vapor pressure and melting point (at 25° C) estimated by EPIWIN (see Physical Chemical Properties) were input in the EQC Level I model (v 2.02). The octanol-water coefficient used was the experimentally determined value for 1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio).

EPIWIN, version 3.12[2] and associated algorithms were used to estimate all physical and chemical properties needed for the EQC model.

The modeled data are shown below. The modeled fugacity results for this compound indicate that these compounds will most likely distribute to some limited degree to water and strongly absorb to soil and sediments.

[2] Environmental Science Center- Syracuse Research Corporation- EPI for windows.

Medium	Amount % of total released
Air	0.0000024
Water	5.84
Soil	92.0
Sediment	2.05
Suspended particles	0.064
Fish	0.0052

6.0 ECOTOXICOLOGY DATA

6.1 Aquatic Ecotoxicity Testing

6.1.1 Acute Toxicity to Fish

The 96 hour LC_{50} of 1,3,4-thiadiazole, 2,5-bis(tert-nonyldithio) determined in fathead minnows is > 1000 mg/L. The NOEL is 1000 mg/L.

6.1.2 Acute Toxicity to Daphnia

The No Observed Effect Concentration was <0.063 mg/L. The 48-hour EC50 value was >1.0 mg/L, the highest concentration tested. The no mortality/immobility concentration was 0.063 mg/L

6.1.3 Acute Toxicity to Algae

Both the growth and the growth rate of *Pseudokirchneriella subcapitata* were unaffected by the presence of the test material over the 72-hour exposure period. The 72-hour E_bC_{50}, the concentration that reduced the area under the growth curve by 50%, was >1.0 mg/L. The 72-hour $E_rC_{50,}$ the concentration that reduced growth rate by 50%, was >1.0 mg/L. The 72-hour No Observed Effect Concentrations (NOEC) for area under the growth curve and growth rate were 1.0 mg/L (based on statistical significance).

7.0 MAMMALIAN TOXICOLOGY DATA

7.1 Acute Mammalian Toxicity

7.1.1 Acute Oral Toxicity

LD50 (rat) > 10 g/kg (males and females)

7.1.2 Acute Inhalation Toxicity

LC50 (rat) > 2.75 mg/L nominal concentration

7.1.3 Acute Dermal Toxicity

LD50 (rabbit) > 2.0 g/kg (males and females)

7.2 Mutagenicity

7.2.1 Bacterial Reverse Mutation Assay

The test substance was not genotoxic in this assay with or without metabolic activation.

7.2.2 In Vitro Chromosomal Aberration Assay in CHO Cells

The test substance was not mutagenic at any level in this assay with or without metabolic activation.

7.3 Repeated-dose, Reproductive and Developmental Toxicity

7.3.1 Repeated-dose Toxicity

A 28 day oral (gavage) toxicity study was conducted in accordance with OECD 407 guidelines in rats. 1,3,4-thiadiazole 2,5-bis(tert-nonlydithio) was administered at doses of 0, 50, 200, 1000 mg/kg/day. Treatment-related changes in clinical pathology were noted a 200 mg/kg/day and above.

With specific reference to parameters of reproductive and developmental significance, administration of 50, 200, or 1000 mg/kg/day did not affect the absolute or relative adrenal, pituitary, testes or ovary weights in the males and females following 4 weeks of treatment or after an additional 2 weeks of recovery.

The NOAEL was 50 mg/kg/day.

7.3.2 Reproductive and Developmental Toxicity

No specific testing was conducted on 1,3,4-thiadiazole 2,5-bis(tert-nonlydithio). However, a three-generation reproduction study in rats was conducted as a part of the toxicological evaluation of the structural analog 5-Ethoxy-3-trichloromethyl-1,2,4-thiadiazole (ETMT) by Borzelleca et. al. (1980). ETMT was administered at dietary concentrations of 0, 10, 80 and 640 ppm. The study concluded that no adverse effects were apparent on fertility, gestation, viability, lactation, number of stillborn and mean number of pups born and weaned per litter. Adverse effects occurred only on the 640 ppm diet and these consisted of lower weaning weights of offspring and depressed body weight gains of parent rats. Histopathologic studies on second litter offspring in

the third generation showed no effects of the ETMT treatment. Collectively, these results illustrate that ETMT exposure did not adversely affect reproduction or development of rats. This three generation reproduction study is far more robust than the reproduction/development screening test typically conducted under the HPV program.

In addition, 1,3,4-thiadiazole 2,5-bis(tert-nonlydithio) has a higher molecular weight (466.2 g/mole) compared to ETMT (245.9 g/mole) and also lacks the functional groups that are generally associated with more toxic compounds (such as Cl- groups) in ETMT. Based on these structural characteristics, ETMT is estimated to be more biochemically reactive and likely more toxic compared to 1,3,4-thiadiazole 2,5-bis(tert-nonlydithio). Thus, the ETMT is thought be represent a reasonable estimate (or even over-estimate) of the toxicity of 1,3,4-thiadiazole 2,5-bis(tert-nonlydithio).

Based on the lack of adverse effects of CAS# 89347-09-1 (at doses of 50, 200, and 1000 mg/kg/day) on reproductive organ weights (testes and ovary) in the 28-day repeated dose study and the lack of adverse effects of a similar substance (ETMT) in a 3-generation reproduction study, further testing for reproductive/developmental effects would provide no additional information. Therefore, in support of EPA's commitment to animal welfare and reducing un-necessary testing, no further testing of this substance was undertaken.

TABLE 1

SUMMARY OF DATA

CAS No.: 89347-09-1	Study Results
Physical/Chemical Characteristics	
Melting Point	Not Applicable (liquid)
Boiling Point	Decomposes at >200ºC
Vapor Pressure	8.83 x 10^{-12} mm Hg at 25°C
Partition Coefficient	1.72-2.94 at 21^{o} C
Water Solubility	0.1517-0.4839 mg/L
Environmental Fate	
Photodegradation	half-life = 16.55 min
Hydrolysis	Not expected –stable molecule
Fugacity(Level I)	Predicted Distribution (%) Air – 0.0000024 Water – 5.84 Soil – 92.0 Sediment – 2.05 Suspended Particles – 0.064 Fish – 0.0052
Biodegradation	<10% at 28 days
Ecotoxicity	
Acute Toxicity to Algae	72-hour NOEC = 1.0 mg/L
Acute Toxicity to Invertebrates	48-hour EC50 >1.0 mg/L
Acute Toxicity to Fish	96 Hr LC_{50} > 1000 mg/L 96 Hr NOEL = 1000 mg/L
Mammalian Toxicity	
Acute Toxicity	Rat Oral LD_{50} >10 g/kg Rabbit Dermal LD_{50} > 2 g/kg Rat Inhalation LC_{50} > 2.75 mg/L
Repeat Dose Toxicity	NOAEL – 50 mg/kg/day
Reproductive and Developmental Toxicity	Not expected to have developmental or reproductive effects – based on comparison to other substance (ETMT) for which three generation study is available and on lack of effect on reproductive organs in 28 day study
Genetic Toxicity	
Bacterial Gene Mutation	Not Mutagenic
Chromosomal Aberration	Not Mutagenic